

CLAIMS

1. High yield ratio high-strength thin steel sheet superior in weldability and ductility, characterized by; being comprised of steel containing, by mass%;

5 C: over 0.030 to less than 0.10%,
Si: 0.30 to 0.80%,
Mn: 1.7 to 3.2%,
P: 0.001 to 0.02%,
S: 0.0001 to 0.006%,
10 Al: 0.060% or less,
N: 0.0001 to 0.0070%,
containing further
15 Ti: 0.01 to 0.055%,
Nb: 0.012 to 0.055%,
Mo: 0.07 to 0.55%,
B: 0.0005 to 0.0040%, and
simultaneously satisfying
20 $1.1 \leq 14xTi(\%) + 20xNb(\%) + 3xMo(\%) + 300xB(\%) \leq 3.7$,
the balance comprised of iron and unavoidable impurities,
and
25 having a yield ratio of 0.64 to less than 0.92,
a $TS \times El$ of 3320 or more, an $YR \times TS \times El^{1/2}$ of 2320 or more,
and a maximum tensile strength (TS) of 780 MPa or more.

2. High yield ratio high-strength thin steel sheet superior in weldability and ductility as set forth in claim 1, characterized by further containing, by mass%, one or two of

30 Cr: 0.01 to 1.5%
Ni: 0.01 to 2.0%,
Cu: 0.001 to 2.0%,
Co: 0.01 to 1%,
W: 0.01 to 0.3%.

3. High yield ratio high-strength hot-rolled steel sheet superior in weldability and ductility as set forth in claim 1 or 2, characterized in that said yield ratio is 0.68 to less than 0.92 and in that an X-ray intensity ratio of a {110} plane parallel to the sheet surface at

1/8 the thickness of the steel sheet is 1.0 or more.

4. High yield ratio high-strength cold-rolled steel sheet superior in weldability and ductility as set forth in claim 1 or 2, characterized in that said yield ratio is 0.64 to less than 0.90 and in that an X-ray intensity ratio of a {110} plane parallel to the sheet surface at 1/8 the thickness of the steel sheet is less than 1.0.

5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100 105 110 115 120 125 130 135 140 145 150 155 160 165 170 175 180 185 190 195 200 205 210 215 220 225 230 235 240 245 250 255 260 265 270 275 280 285 290 295 300 305 310 315 320 325 330 335 340 345 350 355 360 365 370 375 380 385 390 395 400 405 410 415 420 425 430 435 440 445 450 455 460 465 470 475 480 485 490 495 500 505 510 515 520 525 530 535 540 545 550 555 560 565 570 575 580 585 590 595 600 605 610 615 620 625 630 635 640 645 650 655 660 665 670 675 680 685 690 695 700 705 710 715 720 725 730 735 740 745 750 755 760 765 770 775 780 785 790 795 800 805 810 815 820 825 830 835 840 845 850 855 860 865 870 875 880 885 890 895 900 905 910 915 920 925 930 935 940 945 950 955 960 965 970 975 980 985 990 995 1000 1005 1010 1015 1020 1025 1030 1035 1040 1045 1050 1055 1060 1065 1070 1075 1080 1085 1090 1095 1100 1105 1110 1115 1120 1125 1130 1135 1140 1145 1150 1155 1160 1165 1170 1175 1180 1185 1190 1195 1200 1205 1210 1215 1220 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5225 5230 5235 5240 5245 5250 5255 5260 5265 5270 5275 5280 5285 5290 5295 5300 5305 5310 5315 5320 5325 5330 5335 5340 5345 5350 5355 5360 5365 5370 5375 5380 5385 5390 5395 5400 5405 5410 5415 5420 5425 5430 5435 5440 5445 5450 5455 5460 5465 5470 5475 5480 5485 5490 5495 5500 5505 5510 5515 5520 5525 5530 5535 5540 5545 5550 5555 5560 5565 5570 5575 5580 5585 5590 5595 5600 5605 5610 5615 5620 5625 5630 5635 5640 5645 5650 5655 5660 5665 5670 5675 5680 5685 5690 5695 5700 5705 5710 5715 5720 5725 5730 5735 5740 5745 5750 5755 5760 5765 5770 5775 5780 5785 5790 5795 5800 5805 5810 5815 5820 5825 5830 5835 5840 5845 5850 5855 5860 5865 5870 5875 5880 5885 5890 5895 5900 5905 5910 5915 5920 5925 5930 5935 5940 5945 5950 5955 5960 5965 5970 5975 5980 5985 5990 5995 6000 6005 6010 6015 6020 6025 6030 6035 6040 6045 6050 6055 6060 6065 6070 6075 6080 6085 6090 6095 6100 6105 6110 6115 6120 6125 6130 6135 6140 6145 6150 6155 6160 6165 6170 6175 6180 6185 6190 6195 6200 6205 6210 6215 6220 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7225 7230 7235 7240 7245 7250 7255 7260 7265 7270 7275 7280 7285 7290 7295 7300 7305 7310 7315 7320 7325 7330 7335 7340 7345 7350 7355 7360 7365 7370 7375 7380 7385 7390 7395 7400 7405 7410 7415 7420 7425 7430 7435 7440 7445 7450 7455 7460 7465 7470 7475 7480 7485 7490 7495 7500 7505 7510 7515 7520 7525 7530 7535 7540 7545 7550 7555 7560 7565 7570 7575 7580 7585 7590 7595 7600 7605 7610 7615 7620 7625 7630 7635 7640 7645 7650 7655 7660 7665 7670 7675 7680 7685 7690 7695 7700 7705 7710 7715 7720 7725 7730 7735 7740 7745 7750 7755 7760 7765 7770 7775 7780 7785 7790 7795 7800 7805 7810 7815 7820 7825 7830 7835 7840 7845 7850 7855 7860 7865 7870 7875 7880 7885 7890 7895 7900 7905 7910 7915 7920 7925 7930 7935 7940 7945 7950 7955 7960 7965 7970 7975 7980 7985 7990 7995 8000 8005 8010 8015 8020 8025 8030 8035 8040 8045 8050 8055 8060 8065 8070 8075 8080 8085 8090 8095 8100 8105 8110 8115 8120 8125 8130 8135 8140 8145 8150 8155 8160 8165 8170 8175 8180 8185 8190 8195 8200 8205 8210 8215 8220 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rolling to 650°C by an average cooling rate of 25 to 70°C/sec and

coiling it at 700°C or less in temperature.

10. A method of production of high yield ratio
5 high-strength hot-dip galvannealed hot-rolled steel sheet
superior in weldability and ductility, characterized by;

heating a cast slab comprised of the
chemical components described in claim 5 to 1160°C or more
directly or after once cooling,

10 hot-rolling it ending at the Ar₃
transformation temperature or more,

cooling the sheet from the end of hot-
rolling to 650°C by an average cooling rate of 25 to
70°C/sec,

15 coiling it at 700°C or less in temperature,
then

running it through a hot-dip galvanizing
line during which making the maximum heating temperature
500°C to 950°C,

20 cooling it to (zinc-coating bath
temperature-40)°C to (zinc-coating bath temperature+50)°C,
then

25 dipping it in a zinc-coating bath and
giving it a skin-pass of a reduction rate
of 0.1% or more.

11. A method of production of high yield ratio
high-strength hot-dip galvannealed hot-rolled steel sheet
superior in weldability and ductility, characterized by;

30 heating a cast slab comprised of the
chemical components described in claim 6 to 1160°C or more
directly or after cooling once,

hot-rolling it ending at the Ar₃
transformation temperature or more,

cooling the sheet from the end of hot-
35 rolling to 650°C by an average cooling rate of 25 to

70°C/sec,

coiling it at 700°C or less in temperature,
then

5 running it through a hot-dip galvanizing
line during which making the maximum heating temperature
500°C to 950°C,

cooling it to (zinc-coating bath
temperature-40)°C to (zinc-coating bath temperature+50)°C,
then

10 dipping it in a zinc-coating bath, then
alloying it at 480°C or more in temperature
and
giving a skin-pass of a reduction rate of
0.1% or more.

15 12. A method of production of high yield ratio
high-strength cold-rolled steel sheet superior in
weldability and ductility, characterized by;

20 heating a cast slab comprised of the
chemical components described in claim 4 to 1160°C or more
directly or after once cooling,

hot-rolling it ending at Ar_3 transformation
temperature or more,

25 cooling the sheet from the end of hot-
rolling to 650°C by an average cooling rate of 25 to
70°C/sec,

coiling it at 750°C or less in temperature,
pickling it, then

cold-rolling it at a reduction rate of 30
to 80%,

30 running it through a continuous annealing
line during which making the average heating rate until
700°C 10 to 30°C/sec and making the maximum heating
temperature 750°C to 950°C,

35 cooling in the cooling process after
heating by an average cooling rate in the range of 500 to

600°C of 5°C/sec or more, then

giving it a skin-pass of a reduction rate of 0.1% or more.

13. A method of production of high yield ratio
5 high-strength hot-dip galvanized steel sheet superior in weldability and ductility, characterized by;

heating a cast slab comprised of the chemical components described in claim 7 to 1160°C or more directly or after cooling once,

10 hot-rolling it ending at the A_3 transformation temperature or more,

cooling the sheet from the end of hot-rolling to 650°C by an average cooling rate of 25 to 70°C/sec,

15 coiling it at 750°C or less in temperature, pickling it, then cold-rolling it by a reduction rate of 30 to 80%,

20 running it through a hot-dip galvanizing line during which making the average heating rate up to 700°C 10 to 30°C/sec and making the maximum heating temperature 750°C to 950°C,

25 cooling it in the cooling process after heating by an average cooling rate in the range of 500 to 600°C of 5°C/sec or more,

30 cooling it to (zinc-coating bath temperature-40)°C to (zinc-coating bath temperature+50)°C, dipping it in a zinc-coating bath, and

giving it a skin-pass of a reduction rate of 0.1% or more.

14. A method of production of high yield ratio high-strength hot-dip galvannealed steel sheet superior in weldability and ductility, characterized by;

35 heating a cast slab comprised of the chemical components described in claim 8 to 1160°C or more

directly or after cooling once,
hot-rolling it ending at the A_3
transformation temperature or more,
cooling the sheet from the end of hot-
5 rolling to 650°C by a cooling rate of 25 to 70°C/sec,
cooling at 750°C in temperature,
pickling it, then
cold-rolling it by a reduction rate of 30
to 80%,
10 running it through a hot-dip galvanizing
line during which making the average heating rate up to
700°C 10 to 30°C/sec and making the maximum heating
temperature 750°C to 950°C,
cooling it in the cooling process after
15 heating by an average cooling in the range of 500 to 600°C
of 5°C/sec or more,
cooling it to (zinc-coating bath
temperature-40)°C to (zinc-coating bath temperature+50)°C,
dipping it in a zinc-coating bath, then
20 alloying it at 480°C or more in
temperature, and
giving a skin-pass of a reduction rate of
0.1% or more.